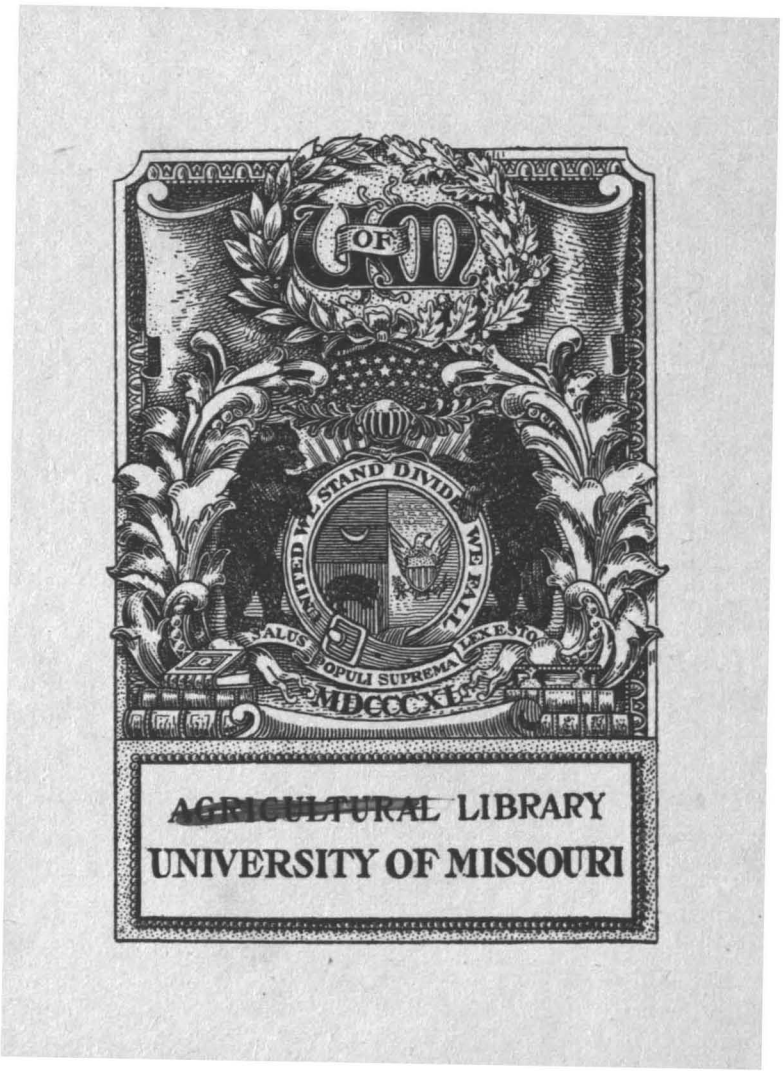

PHOSPHORUS IN BEEF ANIMALS

by

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By

Charles Kenworthy Francis.

Introduction.

This study constitutes but a part of the results obtained from the experiment "Uses to Which the Animal Puts Its Food" now being conducted by the University of Missouri, and considers the quantity and to some extent the character of the phosphorus contained in the organs, tissues, etc., of beef animals.

The investigation is similar to that of Laws and Gilbert # "A knowledge of the quantitative relation of the organs or parts, and of the ultimate and proximate composition of animal bodies, is of great interest in many points of view. Especially is a knowledge of the general composition of animals slaughtered as human food of great importance in the application of chemistry and physiology to dietics. To the farmer, too, who is engaged in producing animal food for consumption ------- it is very desirable to know something of the chemical relations of the substances so produced and sold, to the constituents expended in producing it. In other words,

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#Phil. Trans. part II. 1859.
Composition of Animals, Rothamsted Exp. Sta. 1858.

he should possess some data for determining -- what is the probable proportion of the consumed food, or of its several constituents, which he recovers in the form of meat? How much he may calculate as manure and how much as expenditure or loss by the feeding process."

The investigators quoted above published their conclusions over half a century ago, and added another contribution later # but did not have ac-

#Phil. Trans. 865 (1883).

cess to modern apparatus or methods.

The most recent work in this same field has had for its chief object the perfection of analytical methods. Especially prominent in this respect have been the researches of Zaleski, (1) Hart and Andrews, (2) Koch and Woods, (3) Ivanhoff, (4) Schulze and Castoro, (5) and Emmett and Grindley (6).

(1). Ber. bot. Ges., 20, 426 (1902).
(2). Am. Ch. Jr., 30, 470 (1903).
(3). Jr. Biol. Chem. I. Nos. 2 & 3 (1906).
(4). Bor. bot. Ges., 20, 366 (1902).
(5). Z. phys. Chem., 41, 477 (1903).
(6). Jr. Am. Ch. Soc., 28, 25 (1906). Jr. Ind. & Eng. Chem. I. Nos. 7 & 8 (1909).

Hart, McCullum and Fuller # working with pigs, have shown the role of inorganic phosphorus nutrition. Forbes # has demonstrated that the tender-

#Am. Jr. Phys., 23, 246 (1909).

#Bul. 81, Mo. Exp. Sta.

loin of the pig contains 0.195% to 0.352% phosphorus. Emmett and Grindley #

#Jr. Am. Chem. Soc. 28, 25 (1906) also Ibid 26, 1086 (1904); 27, 658 (1905).

claim that one-fourth of the total phosphorus in beef is in the soluble organic form and that different methods of cooking meat give products which differ as to the quantities and the nature of the phosphorus contents. The same investigators show the composition of several cuts from beef animals.

From unpublished data obtained in this laboratory it appears that raw meat contains fully 75 per cent of its total phosphorus in the organic form, and that the cooking of meat changes the organic phosphorus to an inorganic form depending in extent upon the temperature at which the meat is cooked. Proescher and Abderhalden # demonstrated the relationship bet-

#Zts. f. physiol. chem. 24, 285.

ween the composition of milk of different species and the time required to double the weight of their young according to the following table.#

Table I.

Species	Days from birth required to double weight.	Composition of milk per cents. Protein.	Ash.	Calcium.	Phosphorus.
Man	180	1.6	0.2	0.021	0.022
Horse	60	2.0	0.4	0.086	0.057
Cow	47	3.5	0.7	0.114	0.087
Goat	22	3.7	0.78	0.143	0.122
Sheep	15	4.9	0.84	0.178	0.127

Table I. (Continued)

Species.	Days from birth required to double weight.	Composition of milk per cent. Protein.	Ash.	Calcuim.	Phosphorus
Swine	14	5.2	0.80	0.178	0.135
Cat	9.5	7.0	1.02	-----	-----
Dog	9	7.4	1.33	0.321	0.223
Rabbit	6	10.4	2.50	0.636	0.437

#Zts. f. physiol. chem. 27, 594.

This relationship is extremely interesting and important for, it shows how essential to the development of the animal is the selection of appropriate food.

Character of Animals Slaughtered.

All the animals except Nos. 504, 523 and 525 were fed a mixture consisting of 2.5 parts grain (8 parts cracked corn to 1 part linseed meal) and 1 part alfalfa hay; the three mentioned received 2 parts grain to 1 part alfalfa hay the grain consisting of 6 parts cracked corn. 3 parts whole oats and 1 part linseed meal. The general details of each animal are shown in Table II below.

Character of Animals Slaughtered.

No.	Kind of Animal.	Age.	Condition.	Classification of Carcass.	Remarks.
18	Grade Shorthorn Steer	3 years 6 mos.	Very thin	Cutter	On maintenance 6 mo.
43	Jersey cow	7 years 6 mos.	Fat	#3 Beef	See note A. below.
48	Grade shorthorn Steer	4 years 6 mos.	Very fat	#1 Beef	Full feed for 21 months.
121	" "	3 years 6 mos.	Fairly fat	#1 Beef	" " " " months
504	Grade hereford steer	1 year 9 mos.	Fat	Prime Beef	Full feed all his life.
523	" "	2 years	Medium	#3 Beef	Medium ration all his life.
525	" "	2 years	Thin	Good canner	Ration fed so as to cause ½ lb. gain per day all his life
592	" "	1 year 10 mos.	Emaciated	Poor canner	Submaintenance for 11 months. See note B. below.
594	" "	11 mos.	Fat	#1 Baby beef	Shorthorn blood predominant. Full feed all his life.
595	" "	1 year 9 mos.	Thin	Canner	Maintenance for a year.
597	" "	1 year 6 mos.	Medium	#3 Beef	Fed until fat, then held at maintenance for 7 months.

Note A. Was kept on maintenance for a year, while giving milk, then dried up and held at the same weight until exact requirement was established. Then fattened by increasing the quantity.

Note B. The condition of the skeleton of this steer was remarkable; the marrow have practically disappeared, being replaced with a watery malodorous liquid with none of the properties of normal marrow and totally lacking in greasy or fatty appearances.

An animal on maintenance is held at constant weight. The medium ration

was designed to give the animal maximum thrifty growth without laying on fat. The submaintenance animal was made to lose one-half pound per day.

Method of Obtaining Samples.

At the time of slaughtering, which was done by an expert butcher, the weights of all organs were obtained after which they were grouped according to their functions, for laboratory analysis.

Forty-eight hours later an expert from one of the large packing houses cut the right half of the carcass into the regular wholesale cuts. These were weighed and then separated into lean, fat and bone. In some cases the lean and fat of several cuts was grouped into composite samples for regular analysis and for the determination of the water soluble portion, the composition of which is discussed in this paper.

Preparation of the Samples.

The cut or composite of cuts were first weighed in a tared container, then cut into small pieces and the entire sample passed twice through a meat grinder. First a coarse disc was used in the grinder then a finer one, the sample being completely mixed between each grinding. After quartering the sample was put through the grinder a third time. This process of grinding, (with a gradual reduction of the coarseness of the disc used in the machine) mixing and quartering, was continued until the sample weighed about 1 kilo.

Details of Analytical Methods.

A weighing bottle was nearly filled, about 75 to 100 grams, with the well mixed sample, leaving room for a small aluminum spatula and the glass stopper. After weighing an approximate amount was transferred by means of the spatula to the proper vessel and the exact weight obtained by difference. All determinations were made in triplicate.

Moisture. The moisture content was determined on about 3 grams by the benedict vacuum method of modified for this laboratory.#

#P. F. Trowbridge U. S. Dept. Agri. Bureau of Chem. Bul. 122, p. 215 (1908)
L. F. Shackell, Amer. Jr. Physl. 24, 325 (1909).

Fat. The thimbles from the above determination were placed in Soxhlet extractors and extracted for twenty-four hours with ether distilled from sodium. The ether remaining in the thimble was driven off at a temperature not to exceed 60° C. and the tubes were then dried in vacuum dessicators as per above. The loss in weight represented the fat content. The results were very satisfactory, the triplicates generally agreeing closely.

Ash. About 10 grams of meat (15 grams if fat) were placed in a No. 0 porcelain crucible, heated for about two hours in an oven at 80°, then the temperature gradually raised to about 120°until thoroughly dried. When

dried the sample was charred at a very gentle heat over a Bunsen burner. Very slowly the heat was increased to complete the combustion of the organic material. It was necessary to exercise considerable care to prevent fusion of the ash, frequently two days being consumed in the process. The residue, cooled, weighed and calculated to ash in the fresh sample.

Total Phosphorus. After the estimation of the ash was completed, each crucible was placed in a 250 cc Jena beaker sufficient HNo_3 (1.42) added to fill the crucible, then 10 cc HCl (1.21) together with a few cc (5 to 10) of water, and heated on the water bath for two hours. Some samples needed six or eight hours digestion. The crucible was rinsed with hot distilled water and the contents of the beaker neutralized with NH_4OH (0.90); a slight excess of HNO_3, then 100 cc ammonium molybdate solution and heated to 65^o in a water-bath for one hour. The solution was allowed to stand in a warm place for two hours; filtered (597 S&S or No. 100 Swedish paper) and washed about five times alternately with a solution of NH_4NO_3 which contained 100 grams in a litre#, and with cold water.

#Satisfactory results have been obtained by alternate washings of the filters with NH_4NO_3 solution and water.

The original beaker containing traces of the yellow precipitate was placed under the funnel and the precipitate dissolved with dilute NH_4OH and

hot water. Usually about six washings with 2.5 per cent NH_4OH were sufficient to dissolve the ammonium phospho molybdate precipitate. The solution was then neutralized with HCl and a few drops of NH_4OH added#, cooled, and 15 cc magnesia mixture added slowly, with constant stirring. After a few minutes 15

#W. Pawlenko Vyestink Sakh. Promnish. No. 37, 417 (1906); find that alkaline magnesia mixture gives as accurate results as the neutral mixture. Abs. Exp. Sta. Record 20, 111; (1908).

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to 20 cc NH_4OH (0.90) were added and the solution allowed to stand at least two hours. Filtered and washed with 2.5 per cent NH_4OH solution, until free from chlorides. Dried, ignited to whiteness and weighed as $Mg_2P_2O_7$.

Preparation of the Solution for Soluble Phosphorus. Of the lean meats exactly 120 grams were weighed out in three portions, or 180 grams of fat samples in four weighings, and distributed into twenty 100 cc Jena beakers#

#The beakers were numbered and the division of the different portions indicated, so that if a beaker was broken it was not necessary to reweigh the whole sample, but only that portion from which the loss occurred.

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in approximately equal amounts. 50 cc of recently boiled nitrogen-free water were measured out and the portion of meat in beaker No. 1 moistened with about 5 cc, then mixed with a stirring rod to a pasty condition; more water added and mixed until the whole 50 cc had been added. This operation was repeated with each of the 20 beakers. After standing about one-half hour with frequent stirring, the extract was poured onto 11cm (#595 S&S)

filters and filtered into 300 cc Florence flasks without permitting the major portions of the residue to flow from the beakers. If during the process, any considerable amount of the meat residue collected upon the filter, it was returned to the corresponding beaker with the aid of the stirring rod. Next 25 cc of the neutral nitrogen free water was added to the residue in each beaker, mixed thoroughly and poured on the filter when the first portion of the extract had all passed through. This was repeated until eight 25 cc portions of the water had been used in addition to the first 50 cc portion, making 250 cc of extract from each portion. The residue in the beaker was transferred to the filter with the last 25 cc of water, the beaker and filter washed twice with 10 cc portion of water. This made a total of 270 cc of water used for each flask.

The extract was transferred to a 2 litre measuring flask and then to a glass stoppered bottle of approzimately 8 litres capacity. Each Florence flask was rinsed twice with about 12 cc of water and all made up to the mark on the 2 litre flask (3rd time) with water. The 6 litres# of the extract

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#Excess of solution was used for other determinations than those mentioned below.

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were mixed, avoiding acration, and filtered through a dry filter.

Total Soluble Phosphorus. 500 cc portions of the extract were measured

into 600 cc beakers and evaporated on the water bath to a volume of about 50 cc with the aid of 15 cc H_2SO_4 and hot water, this was transferred to 500 cc nitrogen flasks. Then about 0.7 grams mercury together with 5 grams of potassium sulphate were added and the solution digested as for nitrogen determinations.

After cooling, the liquid and any residue were washed into a 250 cc beaker, slightly diluted with water and neutralized with NH_4OH. The operation was then completed as under total phosphorus.

Soluble Organic Phosphorus.# 600 cc portions of the extract were measured into 1000 cc Erlenmeyer flasks, 5 cc of a 10% $BaCl_2$ solution, 10 cc of NH_4OH (1-1) and 45 cc H_2O added making a total of 660 cc representing 12 grams of the original sample; thoroughly mixed, covered with a watch glass and allowed to stand over night or until the precipitate had settled. Filtered through a dry filter and 605 cc (11/12) of the filtrate#, placed in a dry 1000 cc Erlynmeyer flask, 10 cc of a 5% K_2SO_4 solution and 45 cc of water added, making a total volule of 660 cc. Thoroughly mixed and allowed to stand long enough for the precipitate to settle, then filtered or decanted, according to the contition of precipitate. 600 cc (5/6 of the original sample)

#Seigfried & Singewald, Zts. Nahr. Genussm 10, 52; (1905)

#Representing 11 grams of the sample of lean meat or 16.5 grams of fat meat.

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were measured into 800 cc beakers and treated in the same manner as under total soluble phosphorus above.

Soluble Inorganic Phosphorus. The difference between the organic and the total soluble phosphorus, was considered to be inorganic phosphorus.

Originally attempt was made to ascertain the amount of this constituent by means of Hart and Andrews method (l.c.) as modified by Emmett and Grindley (l.c.) but the results were not satisfactory. The method was used on a considerable number of samples, the results of which compared favorably with those of Emmett and Grindley, showing practically all of the phosphorus present to be in the inorganic form. However, it became apparent that the percentage of organic phosphorus, when obtained by differences, did not correspond with actual organic phosphorus according to the method of Seigfreid and Singewald (l.c.). It was thought that an error was introduced through the fact that in the Emmett and Grindley method, and all others met with in the literature, the solution was heated before precipitation. Data obtained in this laboratory from experiments on the cooking of meats seemed to warrant the above assumption. These experiments, as previously mentioned, indicated that the inorganic phosphorus was increased through the cooking. In order to study this question and compare the methods a series of experiments were undertaken.

EXPERIMENTS WITH WATER SOLUTIONS OF BEEF.

The solutions were prepared by mixing 600 grams of the lean meat with about 1000 cc of water and pouring on a cheese cloth filter. After squeezing the residue was returned to the mixing vessel (a thick glass jar), another 1000 cc portion of water added and after mixing again poured on the filter. This operation was repeated six or seven times. The volume of the liquid was made up to 15 litres and then divided into three parts, a. b.c. of 5 litres each and each portion filtered through a dry filter, 18 cm. S&S 595.

Part a was analyzed as follows:

1-Three portions of 500 cc each marked G(H&A) for inorganic phosphorus according to Emmett and Grindley's# modification of Hart and Andrew's method.

#Jr. Am. Ch. Soc. 28, 25 (1906).

2-Three portions of 500 cc each, marked g. h. i. for total soluble phosphorus by the method described above.

3-Three portions of 600 cc each marked j. k.l. for organic phosphorus by Seigfreid and Singewald's method already mentioned.

Part b was placed in a large Florence flask of about 6.5 litres capacity, closed with a rubber stopper fitted with a reflux condenser and from

which a thermometer was suspended in the liquid. The flask was then immersed in a deep water bath and stirred by shaking occasionally while the temperature was gradually raised to about 60° and maintained for 15 minutes. The temperature of the liquid and the bath were recorded every five minutes and at no time were the two readings over a few degrees apart.

After cooling, usually over night, the solution was filtered and then analyzed by the same methods mentioned for part a.

Part c was also heated under the same conditions, but the temperature in each case was somewhat higher than that employed for part b. The time during which the maximum temperature was maintained was the same.

The results of these experiments are set down in Table III.

Effect of Heat upon the Form of Phosphorus in Meat Solutions.

No.	Source of Sample	Maximum Temperature	Phosphorus (per cents) Total.	Organic.	Inorganic by difference	Inorganic by G(H&A).
993a	Round lean	Cold (20°)	0.164	-----	-----	0.147
			0.165	0.106	0.059	0.142
			0.162	0.067	0.095	0.146
b		60.2°	0.164	0.014	0.150	0.145
			0.164	0.913	0.151	0.139
			0.164	0.012	0.152	0.131
c		70.2°	0.146	0.012	0.134	0.125
			0.143	0.012	0.131	0.126
			0.144	0.017	0.127	0.129
91118a	Chuck & Neck steer #523	Cold (20°)	0.131	0.086	0.045	-----
			0.130	0.086	0.044	-----
			0.127	0.082	0.045	-----
b		70.3°	0.126	0.024	0.102	0.094
			0.126	0.022	0.104	0.079
			0.126	0.023	0.103	0.077
c		90.7°	0.125	0.016	0.109	0.070
			0.125	0.022	0.103	0.079
			0.127	-----	-----	-----
9928a	Round lean	Cold (20°)	0.136	0.070	0.066	0.132
			0.146	0.104	0.042	0.125
			0.146	0.092	0.054	0.129
b		50°	0.147	0.067	0.080	0.126
			0.147	0.066	0.081	0.131
			0.146	-----	-----	0.133
c		70.5°	0.144	0.024	0.120	0.125
			0.146	0.025	0.121	0.130
			0.146	0.024	0.122	0.127
91027a	Lean composite from Cow #4.	Cold (20°)	0.118	0.062	0.056	0.118
			0.137	0.080	0.057	0.118
			-----	0.083	-----	0.117
b		51.7°	0.025	0.025	0.073	0.118
			0.139	0.033	0.106	0.119
			0.111	-----	-----	0.117
c		70.2°	-----	0.027	-----	0.120
			0.139	0.028	0.111	0.118
			0.139	0.028	0.111	0.118

Discussion of Data.

The above results include the data from the prelininary tests, and while the figures are not as uniform as those obtained from later experiments, when the details had been perfected, the general trend is to be observed.

Attention should be called to the fact that part a, 91118, was prepared according to the regular water extract method, as described on page , while parts b and c were made by weighing another portion of the same sample and extracting by the special method adopted for these tests. The total soluble phosphorus determinations indicate the efficiency of the special method, at least so far as the phosphorus content is involved.

Since in the regular analysis of the cold water extracts only the Seigfreid and Singewald method was used, the determinations by the Emmett and Grindley method are lacking for part a. In the same series parts b and c, heated to 70.3° and 90.7° respectively, the inorganic phosphorus determined according to Emmett and Grindley shows considerably lower results than with any of the other experiments, this descrepancy cannot be explained.

A comparison of the total phosphorus in the cold solution with that obtained after removing the coagulum formed by heating at the different tem-

peratures, indicates that practically no phosphorus is precipitated with the coagulum. This conclusion agrees with that of Emmett and Grindley.#

#Jr. Am. Ch. Soc. 28, 63 (1906).

A portion of the organic phosphorus is converted into the inorganic form when heated above 50° and therefore the method proposed by Emmett and Grindley, or any method which involves heating of the cold water extract before precipitation of the inorganic phosphorus, cannot represent the true condition of the phosphorus in the flesh.

The relation of the inorganic and organic phosphorus to the total phosphorus as shown in the above table, may be seen in Table IV in which the data has been averaged and calculated to per cents in each case.

TABLE IV.

Percentage Relation of Organic and Inorganic.

Phosphorus to Total Phosphorus in Meat Solutions.

Number.	993			91118.		
Part	a.	b.	c.	a.	b.	c.
Temperature.	Cold	60.2°	70.2°	Cold	70.3°	90.7°
Total Phosphorus.	100.0	100.0	100.0	100.0	100.0	100.0
Organic Phosphorus.	52.76	7.93	9.44	65.73	18.25	15.25
Inorganic Phosphorus by Difference.	47.24	92.07	90.56	34.27	81.75	84.80
Inorganic Phosphorus by E. & G.	88.41	84.14	88.19	-----	65.71	57.14

	9928.			91027.	
a.	b.	c.	a.	b.	c.
Cold	50.0°	70.5°	Cold	51.7°	70.2°
100.0	100.0	100.0	100.0	100.0	100.0
62.23	45.23	16.72	58.82	25.00	20.14
37.77	54.77	83.28	41.18	75.00	79.86
90.20	88.43	86.98	92.12	101.7	85.61

In the samples examined it appears that the cold extracts contained from 52 to 65 per cent of the total soluble phosphorus in the organic form, which when heated to about 70°, was reduced to from 9 to 20 per cent, accompanied by a corresponding increase of the inorganic phosphorus. The change occurred to a greater or less degree at other temperatures, but seemed to be practically complete at 70° as is especially shown in series 91118. Here it will be observed that there was only three per cent less organic phosphorus in the solution after heating to 90.7° than was found in part b which had been heated to 70.3 degrees.

Water Extracts of Beef.

The data presented in this part was obtained from the analyses of selected cuts from steers 504, 523 and 525. The history of these animals has been given on page , they were in the order named above, fat, medium and thin respectively. For purposes of comparison and to help interpret the results, water and fat determinations made on the original sample are included in the tables. All analytical data is expressed in per cents.

Table V.

Partial Composition of Selected Cuts from Steer No. 504.

Number	Description of Sample	Total Soluble Solids	Water	Fat.
81220	Lean & Fat of Shin, Shank, Head & Tail.	3.44	60.64	20.56
81221	Lean & Fat of Chucks & Neck.	3.69	58.33	24.03
81222	Lean & Fat of Flanks & Plates.	2.27	41.64	45.62
81223	Lean & Fat of Rumps.	2.55	40.72	46.81
81224	Lean of Rounds.	5.98	69.51	9.21
81225	Fat of Rounds.	0.57	16.61	78.03
81226	Lean of Loins.	5.16	66.92	12.22
881227	Fat of Loins.	0.43	11.62	84.91
81228	Lean of Ribs.	4.63	63.28	17.52
81229	Fat of Ribs.	0.75	14.42	80.63

Phosphorus Total.	Phosphorus Insoluble	Soluble Phosphorus.				
		Total	Total Water & Fat Free.	Total Fat Free	Inorganic	Organic
0.143	0.045	0.098	0.710	0.123	0.089	0.010
0.146	0.046	0.100	0.567	0.131	0.131	0.017
0.101	0.032	0.069	0.537	0.126	0.029	0.041
0.106	0.029	0.077	0.617	0.145	0.031	0.046
0.194	0.013	0.181	0.850	0.199	0.093	0.088
0.030	0.019	0.011	0.205	0.050	0.011	0.000
0.181	0.058	0.123	0.589	0.140	0.073	0.050
0.025	0.010	0.015	0.432	0.099	0.014	0.013
0.167	0.039	0.128	0.666	0.155	0.088	0.040
0.031	0.017	0.014	0.282	0.072	0.015	0.000

From the data reported in Table V it is evident that the round lean contains more phosphorus, in forms which are soluble in cold water, than any of the other cuts; the lean of the loin containing the smallest amount. The following table shows the quantity of the total phosphorus which is soluble.

Table VI.

Cuts of Steer No. 504 Arranged According to

Percentage of Total Phosphorus which is Soluble.

Description of Sample.	Total Phosphorus which is Soluble. (per cent)
Round lean	93.3
Rib lean	76.6
Rump	72.6
Shin, shank, head & tail.	68.5
Chuck & neck	68.4
Flank & plate	68.3
Loin lean	67.9
Loin fat	60.0
Rib fat	55.1
Round fat	36.6

The soluble inorganic phosphorus ranges from 0.011 to 0.015 per cent in the fats examined; from 0.029 to 0.089 in those cuts in which the lean and fat was combined; from 0.073 to 0.093 in the lean cuts.

Table V seems to indicate that the lean round, a medium priced cut,

contained practically the same amount of total phosphorus as the lean loin, an expensive cut. Moreover, the amount of soluble phosphorus was considerably less in the lean loin.

To aid in the study of these relations the data was arranged in the order of the total soluble phosphorus content as shown in Table VII.

Table VII.

Cuts of Steer No. 504 Arranged According to Percentage of Total Soluble Phosphorus Referred to the Following Conditions of the Cuts.

	Fresh	Water & Fat Free	Fat Free	Weight of Cuts, grs.
Fat of Rounds	0.011	0.205	0.050	9818
Fat of Ribs	0.014	0.282	0.072	6770
Fat of Loins	0.015	0.432	0.099	18430
Lean & fat of flanks & plates	0.069	0.537	0.126	49650
Lean & fat of rumps	0.077	0.617	0.145	10846
Lean & fat of shins, shanks, head & tail	0.098	0.710	0.123	16070
Lean & fat of chucks & neck	0.100	0.567	0.1313	59808
Lean of loins	0.123	0.589	0.140	33676
Lean of ribs	0.128	0.666	0.155	18506
Lean of rounds	0.181	0.850	0.199	37238
Composite #	0.076	0.543	0.127	76566

#The results shown here were obtained by calculation from the data reported on the fat and lean of the following; shin, shank, head and tail; flank and plate; rump.

It appears from the above tables dealing with steer No. 504 that the fats contained very little soluble phosphorus, an average of 0.013 per cent; the cuts in which the lean and fat were combined for analysis contained from 0.07 to 0.10 per cent; the lean cuts from 0.12 to 0.18 per cent. When the results are reduced to a dry and fat free condition the percentage of total soluble phosphorus in the fats becomes 0.2 to -.43; lean meat referred to the same basis contains from 0.59 to 0.85 per cent. When the meat is freed from both water and fat the results are raised considerably; the fats to 0.20 to 0.43; the lean cuts to 0.53 to 0.85.

Table VIII.

Partial Composition of Selected Cuts from Steer No. 523.

Lab. Number	Description of Sample.	Total Soluble Solids	Water	Fat	Soluble Phosphorus. Total	Total Water & Fat Free.	Total Fat Free.	Inorganic	Organic
91118	Lean & Fat of Chuck & Neck.	4.83	72.78	10.29	0.129	0.762	0.144	0.043	0.086
91121	Lean of Round	5.59	78.26	1.93	0.154	0.777	0.157	0.029	0.125
91122	Fat of Round	1.03	35.63	60.22	0.027	0.190	0.068	0.015	0.012

Table VIII. (Continued.)

Lab. Number.	Description of Sample.	Total Soluble Solids.	Water.	Fat.	Soluble Phosphorus. Total	Total Water & Fat Free.	Total Fat Free.	Inorganic.	Organic.
91123	Lean of Loin	5.82	74.07	10.41	0.152	0.979	0.169	0.053	0.099
91124	Fat of Loin	0.82	16.50	77.94	0.016	0.286	0.073	0.005	0.011
91125	Lean of Rib	4.59	75.40	9.30	0.139	0.908	0.153	0.067	0.072
91126	Fat of Rib	1.49	24.11	64.98	0.029	0.266	0.083	0.013	0.016
91136	Composite of Leans & Fats Exclusive of above Samples.#	3.23	63.80	20.41	0.105	0.664	0.132	0.029	0.076

#This composite sample was made by combining aliquot parts of the lean and fat of the following: shin, shank, head and tail; flank and plate; rump.

Table IX.

Cuts of Steer No. 523 Arranged According to Percentage of Total Soluble Phosphorus. Referred to Different Conditions of the Cuts.

	Fresh Condition.	Water & Fat Free condition.	Fat Free Condition.	Weight of Cuts. Grams.
Fat of Loin	0.016	0.286	0.073	3188
Fat of Round	0.027	0.190	0.068	2278
Fat of Rib	0.029	0.266	0.083	761
Composite	0.105	0.664	0.132	----

Table IX. (Continued.)

	Fresh Condition.	Water & Fat Free condition.	Fat Free Condition.	Weight of Cuts. Grams.
Lean of Fat of Chuck & Neck	0.129	0.762	0.144	24535
Lean of Rib	0.139	0.908	0.153	6016
Lean of Loin	0.152	0.979	0.169	12917
Lean of Round	0.154	0.777	0.157	16946

The above tables referring to steer No. 523, show that the fresh samples contain a little more phosphorus than the corresponding cuts from steer No. 504. The relation does not hold though when the results are compared on a fat free basis; the average results of both only differeing in the third place. This is of some interest in view of the fact that No. 504 had been well fed all his life, while No. 523 had only a medium ration. However the former produced a carcass that graded Prime while the latter's carcass graded No. 3.

Table X.

Partial Composition of Selected Cuts from Steer No. 525.

Lab. Number.	Description of Sample.	Total Soluble Solids.	Water.	Fat.	Soluble Phosphorus. Total	Total Water & Fat Free.	Total Fat Free.	Inorganic.	Organic.
91168	Lean & Fat of Chuck & Neck	4.77	72.99	8.43	0.133	0.716	0.145	0.040	0.093
91171	Lean of Round	5.83	79.85	3.33	0.158	0.933	0.163	0.038	0.120
91172	Fat of Round	1.29	40.19	56.25	0.029	0.814	0.066	0.013	0.016
91173	Lean of Loin	5.72	76.66	3.35	0.159	0.795	0.164	0.031	0.128
91174	Fat of Loin	1.12	25.58	70.75	0.019	0.518	0.065	0.007	0.012
91175	Lean of Rib	4.71	70.51	8.68	0.141	0.677	0.154	0.019	0.122
91176	Fat of Rib	1.77	30.36	61.43	0.032	0.983	0.083	0.015	0.019
91196	Composite of Leans & Fats Exclusive of above Samples.#	3.71	65.43	17.29	0.112	0.648	0.135	0.028	0.084

#Obtained in the same way as noted under Table VIII.

Table XI.

Cuts of Steer No. 525 Arranged According to Percentage of Total Soluble Phosphorus. Referred to Different Conditions of the Cuts.

	Fresh Condition	Water & Fat Free Condition.	Fat Free Condition.	Weight of Cuts. Grams.
Fat of Loin	0.019	0.518	0.065	1879
Fat of Round	0.029	0.814	0.066	981
Fat of Rib	0.032	0.389	0.083	332
Composite	0.112	0.648	0.135	----
Lean & Fat of Chuck & Neck.	0.133	0.716	0.145	17912
Lean of Rib	0.141	0.677	0.154	5833
Lean of Round	0.158	0.933	0.163	13762
Lean of Loin	0.159	0.795	0.164	9355

It will be noticed in tables X and XI referring to No. 525, that the lean of the round and loin cuts contains about the same amounts of soluble phosphorus when compared on either the fresh sample, or the same reduced to a fat free basis. When calculated to a dry and fat free condition the soluble phosphorus in the round is considerably increased over that of the lean loin and other cuts.

Steer No. 525 was a thin animal having been so fed that he gained only one-half pound daily during his life of two years. When slaughtered he was thin, the carcass grading as a good canner. Or in other words, the carcass would be used

by the packers for dried beef, corned beef, etc., the quality not being good enough for sale in the retail market as fresh beef.

Discussion of the Data.

The average per cents, disregarding the weights of the cuts, of total soluble phosphorus reduced to a fat free basis, for the loin, rib and round fats of steers 504, 523 and 525 were 0.074, 0.071 and 0.071 respectively; the lean portion of the loin, rib and round contained 0.165, 0.160 and 0.160. The soluble phosphorus in the same lean cuts when reduced to a moisture and fat free condition, averaged for the three animals as follows 0.702, 0.888 and 0.802, named in the same order as above.

The average per cents of the soluble phosphorus in the fats calculated according to weight are as follows:

Fresh Substance. Round fats 0.015 per cent, rib fats 0.016 per cent, loin fats 0.015 per cent.

Water and Fat Free Substance. Round fats 0.298 per cent, rib fats 0.282 per cent, loin fats 0.411 per cent.

The soluble phosphorus of the lean portions averaged in the same way as the preceeding, appears as follows:

Fresh Substance. Lean rounds 0.169 per cent; lean loins 0.135 per cent; lean

ribs 0.133 per cent.

Water and Fat Free Substance. Lean rounds 0.856 per cent; lean loins 0.693 per cent; lean ribs 0.715 per cent.

F. W. Woodman of this laboratory has shown # that the fat, ether soluble,

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#Jr. Ind. & Eng. Chem. 1, 1909.

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extracted from bones contained but 0.003 per cent total phosphorus.

The above demonstrates very clearly that the phosphorus in beef flesh is found chiefly in the muscular or connective tissue.

A comparative study cannot be made of the forms of phosphorus found in the water extracts prepared from the three animals, because soluble inorganic phosphorus was determined in samples from steer No. 504 by the Emmett and Grindley method. It has been demonstrated, page , that their method gives results which are too high.

It is possible that the condition of the animal may influence the relative amount of organic phosphorus and it is unfortunate that this point cannot be cleared up here. Another investigation conducted in this laboratory, working on the composite sample from a very thin animal, shows that 26 per cent of the soluble phosphorus is organic. Cuts from a very fat animal show from 52 to 70 per cent of the soluble phosphorus to be in organic forms. Another fat animal

gives even higher figures for this component 72 to 87 per cent.

To avoid variables, the weights of the lean and fat of each cut were added and from the percentage composition, a new per cent for soluble phosphorus was computed which then represented the entire cut. The per cent of soluble phosphorus thus obtained was reduced to a fat free, and moisture and fat free condition. The results of this computation are given in Table XII.

Table XII.

Soluble Phosphorus in the Cuts Calculated to Fat Free,
and Water and Fat Free Substance.

Basis of Comparison.	Fresh Substance.			Water & Fat Free.			Fat Free.		
Number of Steer.	504	523	525	504	523	525	504	523	525
Chuck & Neck	.100	.129	.133	.567	.762	.716	.131	.144	.145
Round	.145	.139	.149	.807	.774	.934	.189	.132	.157
Loin	.084	.125	.135	.577	.923	.782	.135	.163	.159
Rib	.097	.126	.135	.630	.850	.670	.147	.149	.152
Composite	.076	.105	.112	.543	.664	.648	.127	.132	.135

If we study Table XII, which really includes most of the others pertaining to the analytical results of the animals under discussion, several things become apparent.

The fresh substance of 504 contains less soluble phosphorus than the other

animals, the round cut excepted; steer 525 contains more than 504 and 523 in every instance. The composite representing the cheapest cuts in the animal, contains the least, while the round, a medium priced cut, contains the most.

When the soluble phosphorus is expressed in terms of water and fat free substance, the round of 504 and 525 are highest, but the loin contains the most in the cuts from 523. The cheap cuts remain uniformly low.

It is difficult to surmise a reason why the round cut is high in phosphorus. A glance at the total solids which are soluble in water, seems to indicate the same tendency. The round cut consists of muscular tissue subjected to considerable work and but seldom relaxed; it contains more water than the other cuts and is high in total soluble solids. Such conditions would naturally favor the retention of soluble phosphorus compounds. Moreover it would indicate more muscle plasma than the other cuts, the rib or loin for example.

There remains to be discussed the influence of age and condition.

Steers 523 and 525 were the same age, but the soluble phosphorus content, fresh substance, of 523 is uniformly lower. Steer 504 was three months younger, and the cuts from it contain the least soluble phosphorus. A glance at the second division of Table XII will suffice to show there is no age relation on the water and fat free basis. It is impossible therefore, to say that age has any influence

in this respect.

As to condition, it will be recalled that 504 was fat, 523 medium,and 525 thin. On the basis of the fresh meat, it appears that the thin animal contains in each cut more soluble phosphorus than the others; No. 523 more than 504 with the exception of the round cut. On the water and fat free basis it will be observed that the cuts of 525 are above those of 504 except the loin and rib and if the round is not considered; No. 523 contains more soluble phosphorus than 504.

These results appear to show that the flesh of the thin animal contains more soluble phosphorus than the fat one; also that the quantity decreased with increasing fatness even when reduced to a moisture and fat free basis.

Conclusions.

1. A method which involves heating of the solution before precipitation of the inorganic phosphorus, does not yield results which represent the true condition of the soluble forms of phosphorus compounds in cold water extracts of beef.

2. Soluble organic phosphorus compounds existing in beef and in cold water extracts of the same, are converted into inorganic forms by heat.

   a. The change is practically complete when the temperature is maintained at 70° for fifteen minutes.

   b. From 52 to 65 per cent of the total phosphorus in cold water extracts is

in the organic form, but may be reduced to from 9 to 20 per cent if heated to about 70° accompanied by a corresponding increase of the inorganic phosphorus.

3. The round cut of beef contains more phosphorus, in forms which are soluble in cold water, than any of the other cuts.

4. Phosphorus is found chiefly in the muscular or connective tissue, the fats contain but little.

5. The flesh of a thin animal contains more soluble phosphorus than that of a fat animal.

   a. The quantity decreased with increasing fatness even when it is expressed on a moisture and fat free basis.

PART II.

Distribution of Phosphorus in Tissues and Organs.

The fresh samples were analyzed by the methods previously described#.

#Ibid.

Mositure and fat, ash and total phosphorus were determined on separate samples in triplicate. The average results are reported.

Eight animals are considered in the following tables. Animals 592, 595, 597, and 594 were young and in various conditions as indicated in Table II previous paper. The next four, 18, 121, 48, and 43 were mature; also varying in condition.

Method of Obtaining Samples.

The samples of blood and the organs were obtained at the time of slaughtering. Forty-eight hours later, when the right half of the carcass was cut into wholesale cuts, the lean, fat and bone samples were taken for analysis. In each case the entire cut was ground, as previously described, before the sample was sent to the laboratory.

Samples Analyzed.

The organs, tissues, etc., were analyzed as shown in the outline below. In many cases it was necessary, owing to the lack of time, to combine several parts, these are indicated by being set to the right under the general head. The analyses

of the bone samples are not included in this paper.

Blood.

Liver.

Digestive and excretory system.

Tongue, total, less bones.

Gullet.

Stomach clean, less fat.

Intestines.clean, less fat.

Spleen.

Pancreas.

Thymos neck.

" heart.

Gall bladder and contents.

Kidneys.

Bladder, less contents.

Penis or (Uterus and Vagina).

Diaphragm (skirt).

Circulatory system.

Heart.

Pericardium and fat.

Arteries.

Respiratory system.

Trachea.

Lungs and fat.

Nervous system.

Brain.

Spinal cord.

Hair and hide.

Offal fat.

Omentum or caul.

Fat from intestines.

Fat from stomach.

Kidney fat.

Lean and fat of head and tail.

Lean and fat of shin and shank.

Lean of round.

Fat of round.

Lean and fat of rump.

Lean of loin.

Fat of loin.

Lean and fat of chuck and neck.

Lean and fat of flank and plate.

Lean of rib.

Fat of rib.

Udder.

It was not possible to adhere to the above outline with every animal, but any change made will appear in the following tables of analyses.

TABLE I.

COMPOSITION OF CUTS AND ORGANS OF STEER NO. 592.

Lab. No.	Samples.	Per cent Moisture.	Per cent Ash.	Per cent Phosphorus	Per cent Fat.
9151	Blood	83.68	0.800	0.019	none
9158	Hair and hide	61.06	1.178	0.039	0.49
9154	Circulatory system	77.41	0.923	0.137	5.49
9155	Respiratory system	79.11	1.162	0.159	5.56
9156	Nervous system	76.21	1.407	0.323	9.78
9157	Digestive and excretory system	82.89	0.863	0.183	3.61
9152	Liver	71.34	1.540	0.333	3.04
9179	Kidney fat	81.42	1.213	0.067	4.59
9178	Offal fat	81.60	1.055	0.109	5.03
9169	Head and tail #	71.89	1.071	0.160	8.69
9170	Shin and shank	76.37	0.979	0.164	1.21
9175	Chuck and neck	77.84	1.040	0.170	1.52
9173	Flank	75.35	0.937	0.130	0.90
9172	Rump	77.36	1.089	0.173	3.04
9171	Round	77.25	1.070	0.184	2.01
9174	Loin	77.16	1.076	0.179	1.62
9176	Plate	75.10	0.996	0.146	3.06
9177	Rib	77.01	1.084	0.168	2.09
9168	Composite of leans and fats.	76.37	1.045	0.174	1.87

#In all carcass cuts lean and fat were combined for analysis, if not otherwise stated.

TABLE II.

COMPOSITION OF CUTS AND ORGANS OF STEER NO. 595.

Lab. No.	Samples.	Per cent Moisture.	Per cent Ash.	Per cent Phosphorus	Per cent Fat.
9251	Blood	80.63	0.747	0.029	none
9258	Hair and hide	64.09	1.422	0.061	1.47
9254	Circulatory system	63.68	0.744	0.145	21.65
9255	Respiratory system	77.99	1.013	0.179	4.05
9256	Nervous system	67.21	1.492	0.361	18.60
9257	Digestive and excretory system	75.34	0.784	0.148	10.92
9252	Liver	70.85	1.473	0.319	3.39
9269	Head and tail lean	72.88	0.961	0.182	7.33
9281	Head and tail fat	49.89	0.587	0.071	32.28
9270	Shin and shank lean	75.08	0.997	0.187	3.00
9282	Shin and shank fat	52.45	0.629	0.065	27.62
9271	Round lean	75.86	1.044	0.203	2.41
9283	Round fat	40.07	0.495	0.062	45.19
9272	Rump lean	73.29	1.050	0.205	5.60
9274	Rump fat	26.40	0.419	0.069	62.39
9273	Flank and plate lean	70.63	0.983	0.180	8.34
9285	Flank and plate fat	36.94	0.516	0.058	46.84
9274	Loin lean	73.21	1.003	0.199	5.48
9286	Loin fat	27.65	0.419	0.064	62.78
9275	Chuck and neck lean	74.73	0.998	0.187	4.21
9287	Chuck and neck fat	41.67	0.529	0.080	46.04
9277	Rib lean	72.82	0.996	0.191	5.67
9289	Rib fat	26.96	0.554	0.082	58.13
9278	Offal fat	31.36	0.319	0.050	62.23
9279	Kidney fat	26.88	0.334	0.050	69.66
9268	Lean composite	73.52	0.997	0.196	4.91
9280	Fat composite	36.79	0.492	0.069	48.54

TABLE III.

COMPOSITION OF CUTS AND ORGANS OF STEER NO. 597.

Lab. No.	Samples.	Per cent Moisture.	Per cent Ash.	Per cent Phosphorus	Per cent Fat.
8951	Blood	80.60	0.339	0.025	none
8958	Hair and hide	61.60	0.646	0.051	2.29
8954	Circulatory system	51.37	0.764	0.125	37.15
8955	Respiratory system	74.75	0.956	0.162	6.16
8956	Nervous system	71.26	1.726	0.417	13.20
8957	Digestive and Excretory system	71.74	0.672	0.122	15.19
8952	Liver	70.30	1.376	0.332	2.70
8980	Kidney fat	7.50	0.115	0.014	90.22
8979	Offal fat	17.97	0.462	0.032	77.88
8970	Head and tail lean	70.97	0.859	0.164	8.98
8982	Head and tail fat	35.69	0.435	0.061	49.97
8971	Shin and shank lean	73.48	0.881	0.170	4.07
8983	Shin and shank fat	40.19	0.326	0.046	44.31
8972	Round lean	74.32	0.956	0.193	3.69
8984	Round fat	26.64	0.285	0.052	65.61
8973	Rump lean	70.77	0.919	0.185	8.18
8985	Rump fat	18.18	0.223	0.040	74.18
8974	Flank lean	67.08	0.907	0.176	11.35
8986	Flank fat	22.24	0.215	0.031	68.20
8977	Plate lean	63.90	0.762	0.148	16.18
8989	Plate fat	24.90	0.253	0.038	66.17
8975	Loin lean	71.64	0.945	0.183	5.94
8987	Loin fat	18.96	0.250	0.044	73.76
8976	Chuck and neck lean	73.07	0.866	0.171	5.69
8988	Chuck and neck fat	29.46	0.315	0.055	58.72
8978	Rib lean	69.01	0.862	0.164	10.26
8990	Rib fat	21.86	0.286	0.051	70.19
8969	Lean composite	71.29	0.928	0.178	8.54
8981	Fat composite	25.49	0.292	0.048	62.92

TABLE IV.

COMPOSITION OF CUTS AND ORGANS OF STEER NO. 594.

Lab. No.	Samples.	Per cent Moisture.	Per cent Ash.	Per cent Phosphorus.	Per cent Fat.
8232	Blood	79.34	0.318	0.055	none
8235	Hair and hide	64.38	0.965	0.072	3.62
8240	Circulatory, respiratory & nervous systems	65.74	0.863	0.181	18.92
8221	Digestive & excretory systems	71.70	0.932	0.193	12.27
8233	Liver	68.82	1.340	0.347	5.27
8244	Kidney fat	5.48	0.072	0.020	93.16
8245	Offal fat	10.96	0.170	0.034	85.87
8288	Shin, shank, head, tail lean	73.64	0.916	0.182	4.94
8289	Shin, shank, head tail fat	41.91	0.445	0.077	44.84
8290	Round lean	72.64	1.024	0.207	5.34
8297	Round fat	20.75	0.243	0.043	71.01
8291	Rump lean	71.22	1.023	0.212	7.23
8298	Rump fat	13.52	0.181	0.036	82.36
8292	Loin lean	70.22	0.986	0.191	8.30
8299	Loin fat	13.41	0.168	0.031	82.47
8293	Flank lean	65.64	0.905	0.176	13.71
82100	Flank fat	19.57	0.151	0.025	72.85
8294	Plate lean	65.09	0.861	0.170	15.47
82101	Plate fat	22.99	0.268	0.044	69.75
8295	Rib lean	68.90	0.856	0.171	10.53
82102	Rib fat	14.27	0.202	0.035	80.32
8296	Chuck and neck lean	72.95	0.916	0.178	6.81
82103	Chuck and neck fat	23.29	0.269	0.046	70.25
8242	Lean composite	71.31	0.985	0.193	6.88
8243	Fat composite	20.05	0.231	0.044	72.90

TABLE V.

COMPOSITION OF CUTS AND ORGANS OF STEER NO. 18.

Lab. No.	Samples.	Per cent Moisture.	Per cent Ash.	Per Cent Phosphorus	Per cent Fat.
71156	Blood	81.29	0.688	0.022	none
71157	Hair and hide	65.36	0.868	0.068	2.88
71167	Circulatory system	56.50	0.751	0.123	30.07
71168	Respiratory system	74.71	0.959	0.151	6.46
71161	Nervous system	68.83	1.757	0.422	17.62
71166	Digestive and excretory system	66.51	1.634	0.129	18.13
71189	Kidneys	75.05	1.085	0.211	8.74
71162	Liver	68.99	1.253	0.311	3.47
71190	Kidney fat	10.04	0.120	0.021	86.96
71165	Offal fat	16.62	0.172	0.027	79.72
71180	Shin, shank, head and tail	67.43	0.771	0.145	11.99
71181	Round and rump	86.50	0.883	0.172	13.26
71182	Loin	59.90	0.788	0.157	21.72
71183	Flank and plate	52.51	0.649	0.124	30.10
71184	Rib	62.79	0.821	0.161	18.04
71185	Chuck and neck	66.48	0.818	0.154	14.07
71159	Skeleton	29.31	24.594	2.796	25.48

TABLE VI.

COMPOSITION OF CUTS AND ORGANS OF STEER NO. 121.

Lab. No.	Samples.	Per cent Moisture.	Per cent Ash.	Per cent Phosphorus	Per cent Fat.
71250	Blood	77.97	0.248	0.028	none
71262	Hair and hide	54.42	0.758	0.056	4.97
71254	Heart lean	77.38	1.000	0.211	4.39
71255	Circulatory system less heart	27.42	0.205	0.039	65.27
71256	Respiratory system	63.96	0.808	0.170	19.69
71257	Nervous system	68.36	1.562	0.395	19.50
71258	Digestive & excretory system less stomach, tongue, liver & Kidneys	55.54	0.633	0.126	31.73
71274	Stomach	78.26	0.971	0.200	8.21
71253	Tongue edible	60.40	0.642	0.132	25.27
71251	Liver	68.36	1.312	0.353	4.72
71260	Kidneys	76.58	0.950	0.229	5.56
71261	Kidney fat	4.48	0.070	0.012	94.67
71259	Offal fat	9.52	0.129	0.022	88.02
71265	Shin, shank, head and tail	62.30	0.733	0.142	18.18
71273	Chuck and neck	59.14	0.702	0.142	24.43
71266	Round and rump lean	69.96	0.957	0.191	8.18
71267	Round and rump fat	14.41	0.153	0.030	80.61
71268	Loin lean	67.22	0.943	0.185	11.40
71269	Loin fat	9.08	0.133	0.024	87.84
71270	Flank and plate	40.07	0.500	0.095	47.70
71271	Rib lean	60.98	0.777	0.153	20.87
71272	Rib fat	10.68	0.135	0.027	86.04

TABLE VII.

COMPOSITION OF CUTS AND ORGANS OF STEER NO. 48.

Lab. No.	Samples.	Per cent Moisture.	Per cent Ash.	Per cent Phosphorus.	Per cent Fat.
91101	Blood	79.41	0.775	0.021	none
91112	Hair and hide	59.24	1.197	0.048	8.60
91105	Heart marketable	65.83	0.835	0.158	19.45
91104	Circulatory system less heart	10.07	0.145	0.026	88.45
91106	Respiratory system	49.42	0.669-	0.117	37.39
91107	Nervous system	69.63	1.813	0.425	13.05
91108	Digestive & excretory system less tongue, stomach & kidney & liver	64.16	0.697	0.128	22.41
91110	Stomach	74.75	1.073	0.227	11.94
91109	Tongue edible	56.02	0.743	0.126	29.50
91102	Liver	69.73	1.392	0.307	4.26
91111	Kidneys	70.75	1.154	0.199	12.16
91134	Kidney fat	3.76	0.126	0.016	94.71
91135	Offal fat	6.22	0.093	0.012	92.09
91120	Shin, shank, head and tail	57.84	0.829	0.142	23.47
91121	Chuck and neck	49.67	0.693	0.123	34.95
91122	Flank and plate	30.15	0.421	0.064	61.11
91123	Rump	36.91	0.509	0.093	52.67
91124	Round lean	64.43	1.015	0.192	13.42
91125	Round fat	27.75	0.251	0.027	67.35
91126	Loin lean	61.73	0.956	0.174	18.26
91127	Loin fat	12.60	0.146-	0.023	84.76
91128	Rib lean	56.86	0.827	0.150	24.74
91129	Rib fat	15.81	0.155	0.021	81.37

TABLE VIII.

COMPOSITION OF CUTS AND ORGANS OF COW NO.43.

Lab. No.	Samples.	Per cent Moisture.	Per cent Ash.	Per cent Phosphorus.	Per cent Fat.
91051	Blood	80.40	0.742	0.030	
91057	Hair and hide	63.30	1.252	0.072	4.27
91054	Circulatory system	47.45	0.505	0.103	46.74
91055	Respiratory system	71.86	0.902	0.164	12.84
91056	Nervous system	72.72	1.441	0.354	13.48
91053	Digestive and excretory system.	76.66	0.736	0.140	10.80
91052	Liver	72.17	1.341	0.339	2.21
91089	Kidney	6.14	0.095	0.016	94.29
91058	Offal fat	11.63	0.074	0.020	88.20
91068	Head and tail lean	68.81	0.889	0.169	13.41
91078	Head and tail fat	27.64	0.345	0.044	66.24
91069	Shin and shank lean	72.44	1.067	0.196	5.65
91079	Shin and shank fat	53.49	0.618	0.061	55.27
91070	Round lean	73.20	1.026	0.195	6.92
91080	Round fat	30.25	0.406	0.059	65.23
91071	Rump lean	67.67	0.955	0.185	12.71
91081	Rump fat	24.02	0.225	0.035	79.34
91072	Loin lean	71.11	0.959	0.186	12.27
91082	Loin fat	16.40	0.189	0.029	82.97
91073	Chuck and neck lean	67.37	0.968	0.184	12.33
91083	Chuck and neck fat	19.96	0.247	0.039	78.00
91074	Flank lean	67.37	1.016	0.188	13.52
91084	Flank fat	26.04	0.289	0.029	70.87
91075	Plate lean	63.27	0.888	0.165	18.80
91085	Plate fat	23.00	0.250	0.041	79.23
91076	Rib lean	65.45	0.907	0.173	17.87
91086	Rib fat	22.86	0.317	0.044	78.45
91077	Composite of leans	69.86	0.966	0.186	12.71
91087	Composite of fats	19.50	0.247	0.033	78.75
91088	Udder	69.37	0.805	0.138	17.19

TABLE IX.

Summary--Phosphorus Calculated to Water and Fat Free

Condition, per cents.

No. of Animal.	592		595		597	
Condition	Fresh.	Moisture & Fat Free	Fresh.	Moisture & Fat Free	Fresh.	Moisture & Fat Free
Blood	0.019	0.116	0.029	0.149	0.025	0.129
Hair and hide	0.039	0.101	0.061	0.177	0.051	0.141
Circulatory system	0.137	0.801	0.145	0.988	0.125	1.088
Respiratory system	0.159	1.037	0.179	0.996	0.162	0.849
Nervous system	0.323	2.305	0.361	2.544	0.417	2.683
Digestive and excretory system	0.183	1.356	0.148	1.077	0.122	0.933
Liver	0.333	1.299	0.319	1.238	0.332	1.229
Kidney fat	0.067	0.479	0.050	1.445	0.014	0.614
Offal fat	0.109	0.815	0.050	0.780	0.032	0.771
Shin, shank, head and tail	0.163	0.762	0.175	0.882	0.145	0.708
Round	0.184	0.887	0.192	0.905	0.171	0.846
Rump	0.173	0.882	0.178	0.927	0.141	0.827
Loin	0.179	0.844	0.185	0.917	0.145	0.791
Flank and plate	0.142	0.637	0.152	0.796	0.114	0.690
Rib	0.168	0.804	0.189	0.883	0.148	0.782
Chuck and neck	0.170	0.824	0.181	0.881	0.153	0.789
Composite of leans and fats	0.174	0.799	0.185	0.877	0.151	0.819

594		18		121		48		43	
Fresh.	Moisture & Fat Free	Fresh	Moisture & Fat Free	Fresh	Moisture & Fat Free	Fresh	Moisture & Fat Free	Fresh	Moisture & F. Free
0.055	0.266	0.022	0.117	0.028	0.127	0.021	0.102	0.030	0.153
0.072	0.225	0.068	0.214	0.056	0.137	0.048	0.149	0.072	0.222
		0.123	0.916	0.103	0.906	0.076	1.756	0.103	1.772
0.181	1.181	0.151	0.802	0.170	1.039	0.117	0.887	0.164	1.071
		0.422	3.114	0.395	3.253	0.425	2.453	0.354	2.565
0.193	1.204	0.131	0.851	0.162	1.131	0.175	0.953	0.140	1.115
0.347	1.339	0.311	1.129	0.353	1.316	0.307	1.179	0.339	1.323
0.020	1.470	0.021	0.700	0.012	1.206	0.016	1.045	0.016	-----
0.034	1.072	0.027	0.737	0.022	0.894	0.012	0.710	0.020	-----
0.164	1.818	0.145	0.705	0.142	0.727	0:142	0.759	0.176	0.899
0.191	0.922					0.146	0.842	0.182	0.983
		0.172	0.850	0.155	0.859				
0.143	0.968					0.093	0.892	0.126	1.176
0.158	0.883	0.157	0.854	0.124	0.857	0.098	0.872	0.141	1.168
0.125	0.798	0.124	0.713	0.095	0.776	0.064	0.732	0.125	1.018
0.149	0.821	0.161	0.840	0.120	0.839	0.082	0.804	0.149	1.112
0.163	0.964	0.154	0.792	0.142	0.864	0.123	0.799	0.158	0.923
0.167	0.869	-----	-----	-----	-----	-----	-----	0.153	1.085

Summary.

In Table IX the phosphorus content for all samples has been calculated to a moisture and fat-free condition. The results for the young animals, 592, 595, 597 and 594, are quite uniform among themselves, but this is not so striking for the other four mature animals.

The largest amount of phosphorus was found in the circulatory systems and the nervous systems. Two of the mature animals, a cow (43) and a steer (48), show abnormally high results in the circulatory systems. Two animals 18--which was 3.5 years old and very thin--and 121,--which was also 3.5 years old but fairly fat--contain more phosphorus in the nervous systems than the other animals. The Jersey cow, which was the oldest animal examined, showed the highest average amount of phosphorus.

So far as the phosphorus in the flesh of the cuts is concerned, it is impossible to draw any final conclusion with the amount of data available. Steer 594, young, fat, and in a very thrifty condition contained more phosphorus--moisture and fat-free basis--than steers 18, 121 and 48, three mature steers. It was also superior in this respect to 592, 595 and 597 which were young but not in so thrifty a condition. The mature cow however showed in the flesh cuts a higher phosphorus content than any of the other animals dis-

cussed. This can hardly be attributed to condition, because 121 was fully as fat, and 48 much fatter. Whether it was due to age is a little doubtful, as she was only two years older than 48. We are more inclined to think that the breed or the high phosphorus diet (bran etc.), previous to the fattening period may have been influential.

The wholesale cuts of the seven steers show an increasing amount of phosphorus, compared on the moisture and fat free basis, in the following order: Flank and plate; shin, shank, head and tail; rib; chuck and neck; loin; round; rump. In other words, those cuts thin in character and which have the largest amount of connective tissue contain the smallest amount of phosphorus.

It is remarkable that the very thin steer 592, while comparatively low in phosphorus, showed a higher percentage of ash in every cut than any of the other animals. Steer 595, also thin, contained somewhat less but still higher than the other remaining animals. Steer 121 well fed and in excellent condition, gave comparatively low results in ash. It is to be noted that there seems to be no relation between the phosphorus and the ash; an explanation of which cannot be attempted until the analyses of the various samples of ash are completed.